

Hospital-based surveillance of malaria-related paediatric morbidity and mortality in Kinshasa, Zaire

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Although Plasmodium falciparum malaria is a leading cause of paediatric morbidity and mortality in Africa, few quantitative estimates are available about the impact of malaria on childhood health. To quantify the impact of the disease in an urban African setting, we reviewed the paediatric ward and mortuary records at Mama Yemo Hospital in Kinshasa, Zaire.

From June 1985 to May 1986, 6208 children were admitted to the hospital, 2374 (38.2%) of whom had malaria; 500 of those with malaria died (case fatality rate, 21.1%). During this same period, there were 10036 paediatric deaths, 1323 (13.2%) of which were attributed to malaria; 823 (62.2%) of these occurred in the emergency ward prior to hospitalization. Minimum population-based malaria mortality rates were highest for children aged <1 year (4.0 per 1000 per year). Over 70% of children admitted with malaria and >80% of children who died from the disease were <5 years old.

The total number of paediatric admissions and deaths remained relatively constant between 1982 and 1986; however, the proportional malaria admission rate increased from 29.5% in 1983 to 56.4% in 1986, and the proportional malaria mortality rate, from 4.8% in 1982 to 15.3% in 1986. These increases were temporally related to the emergence of chloroquine-resistant Plasmodium falciparum malaria in Kinshasa. Malaria is therefore a major cause of paediatric morbidity and mortality in the city, and this study indicates that hospital-based surveillance may be useful in monitoring disease-specific morbidity and mortality elsewhere in Africa.

Introduction

Although *Plasmodium falciparum* malaria is one of the leading causes of paediatric morbidity and mortality in Africa (1), few quantitative estimates of the impact of the disease on childhood survival are available. In 1954, Bruce-Chwatt wrote that "... our knowledge of the amount and distribution of malaria in tropical Africa is still woefully inadequate" (2), and our understanding of the health impact of this disease still remains limited. Despite the importance of surveillance in monitoring the efficacy of malaria control programmes, a multitude of problems have inhibited the reliable assessment of the incidence of malaria cases and death in Africa.

First, it is difficult to formulate a practical case definition for malaria because of the complex relationship between parasitic infection and clinical illness. In Africa, where basic laboratory equipment such as microscopes may be lacking, diagnosis of the disease is generally based on clinical criteria without

parasitological confirmation. Conversely, infection with *P. falciparum* is not always associated with clinical disease because of the development of malarial immunity by residents in endemic areas.

Second, surveillance activities at centralized health facilities cannot adequately detect all cases of malaria because many Africans, especially those living in rural areas, have limited access to medical care. Even when the number of cases of the disease in a region can be ascertained, the rate of malarial illness in a population may be difficult to determine. Accurate census data are often unavailable or subject to rapid fluctuations because of migration or changes in the birth or death rate.

To assess the current impact of malaria on infant and child mortality in an urban African setting, we reviewed morbidity and mortality data at Mama Yemo Hospital, Kinshasa, Zaire. A similar technique, used for a study of malnutrition among Kinshasa children in the 1970s, provided a rapid and inexpensive assessment of disease-specific morbidity (3). While recognizing the limitations of retrospective hospital-based surveillance, we adopted this methodology to quantify malaria-related morbidity and mortality, detect temporal trends in the number of cases of severe malaria, and identify patients at high risk of dying from the disease.

Methods

In Kinshasa, the capital of Zaire, the transmission of malaria is intense and perennial (4). Mama Yemo

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Hospital, with over 2000 beds, is the largest medical centre in Kinshasa and serves as a referral centre for patients with severe malaria who have not responded to antimalarial therapy either at home or at one of the many clinics in the city. Children presenting to the hospital with signs or symptoms that are suggestive of malaria are initially evaluated in the paediatric emergency ward, where a clinical examination and a malaria blood smear are performed routinely. Antimalarial therapy, principally an intravenous infusion of quinine, is given to patients who are diagnosed as having severe disease. Children who respond adequately to the therapy are discharged and treated as outpatients, whereas those whose clinical status has not sufficiently improved after 24–48 hours are admitted to one of the hospital's three paediatric wards. All children who die in either the emergency ward or paediatric wards are registered at the hospital mortuary, where a death certificate (required for burial in Kinshasa) is issued.

Data sources

Paediatric ward records. Upon admission to the hospital from the emergency ward, the child's name, age, sex, address, and diagnosis, made by the physicians in the emergency or paediatric ward, are recorded.

Mortuary records. Upon receipt of the corpse at the hospital mortuary, the name, age, sex, and address of the deceased, together with the cause of death, as reported by the physicians in the emergency or paediatric ward, are recorded. Children who did not die at the hospital but whose corpses were brought to the mortuary solely to have a death certificate issued, or who were dead on arrival at the hospital, are not given a specific diagnosis.

Census data. A census in 1984 estimated that the total population of metropolitan Kinshasa was 2.7 million (5). Since the age distribution of those covered in the census was not available, we used distribution data obtained during a 1978 nutritional survey of Kinshasa (6–7) to approximate the proportions of the population that were in the following stratified age classes: <1 year (4.3%), 1–4 years (15.1%), 5–9 years (16.3%), and 10–13 years (14.1%).

Validity of the diagnosis of malaria

All children diagnosed as having malaria at Mama Yemo Hospital are first evaluated in the emergency ward, where both clinical and parasitological data are used by the physicians to formulate their diagnosis. Because this evaluation was the basis for the diagnosis registered in the paediatric ward and mortuary records and was thus central to this investigation, we conducted the validation studies outlined below.

First, to determine how frequently the diagnosis of malaria in the emergency ward was confirmed parasitologically, we reviewed the medical records of 1000 consecutive patients: 824 were diagnosed as having malaria, of whom 615 (75%) were confirmed by a positive malaria smear, 118 (14%) had a negative smear, and for 91 (11%) either no slide was requested or the results were not recorded. Of the 176 patients not diagnosed as having malaria, 14 (8%) had a positive malaria smear (8).

Second, to assess the diagnosis of malaria among hospitalized patients, we reviewed the records of all 167 children resident in the paediatric wards on 1 July 1986. Of the 112 children diagnosed as having malaria, 83 (74%) had a positive malaria slide, 19 (17%) had a negative slide, and no slide results were available for 10 (9%) (8). These data are similar to those found for the emergency ward.

Patients who are diagnosed as having malaria without parasitological confirmation are usually those with a clinical illness suggestive of the disease, no other identifiable illness, and a history of recent antimalarial drug intake; such patients are diagnosed as having "*paludisme décupité*."

Third, to determine the proportion of children who had undergone prior treatment with antimalarials, we collected samples of venous blood from 140 malaria patients who presented at the hospital's emergency ward. These samples were analysed by high-performance liquid chromatography (HPLC) (9) for chloroquine and quinine, the two most commonly used antimalarials in Kinshasa. Overall, 129 (92%) of the patients had evidence of recent intake of chloroquine and/or quinine (mean chloroquine level among patients pretreated with chloroquine: 559 µg/l; mean quinine level among patients pretreated with quinine, 4.3 mg/l) (unpublished data).

Review of hospital records

One-year survey. We recorded the age, sex, address, and diagnosis of all paediatric malaria-related admissions (paediatric ward records) and deaths (mortuary records) at the hospital between June 1985 and May 1986. The total numbers of paediatric admissions and deaths (from all causes) were also noted, and case-fatality rates (CFRs) for hospitalized malaria patients were determined.

Minimum malaria mortality rates for Kinshasa children were calculated by dividing the number of paediatric malaria deaths recorded at Mama Yemo Hospital by the estimated number of children in the city in the four stratified age classes. Since deaths from malaria that occur at other medical facilities or at home are not routinely registered at the Mama Yemo Hospital mortuary, the rates calculated are underestimates.

Longitudinal survey. To detect trends in malaria-related morbidity from 1983 to 1986, we recorded the total number of admissions from all causes, as well as from malaria, to the largest paediatric ward at Mama Yemo Hospital (pavilion 7; for 3–12-year olds). Also, to detect trends in malaria-related mortality from 1982 to 1986, we recorded the total number of paediatric deaths from all causes and the number of deaths attributed to malaria at the hospital mortuary.

Other causes of paediatric mortality. To compare malaria-related mortality with other leading causes of paediatric mortality at Mama Yemo Hospital, we recorded the number of deaths attributed in the mortuary records to measles and gastroenteritis from January to December 1986. The following were the two largest diagnostic categories for children whose cause of death was not routinely recorded: those who did not die at the hospital but whose corpses were brought to the mortuary for a death certificate; and those who died at the hospital during the neonatal period. The size of these two groups was estimated by determining the percentage attributed to each during a randomly selected month (March 1986) and by extrapolating this to the entire 1-year study period.

Results

One-year survey

Malaria admissions. A total of 6208 children were

admitted to the three paediatric wards in Mama Yemo Hospital from June 1985 to May 1986, of whom 2374 (38.2%) had malaria. More than 70% of the malaria patients were aged <5 years (Table 1 and Fig. 1), and 52.8% were male. Malaria was recorded as the only diagnosis for 42.8% of the cases; and the leading associated diagnoses were anaemia (22.2%), gastroenteritis (10.6%), and pneumonia (9.8%), indicating that malaria was the principal diagnosis in most instances.

Of the 2374 hospitalized children with malaria, 500 died (CFR: 21.1%). The CFR of males (20.0%) did not differ significantly (χ^2 test) from that of females (22.4%). When stratified by age (Table 1), the CFR was highest in children aged <1 year (31.8%) and decreased progressively with age ($P < 0.001$, χ^2 test for trend).

Malaria deaths. A total of 10036 paediatric deaths were registered at the hospital mortuary from June 1985 to May 1986, of which 1323 (13.2%) were attributed to malaria. More than 80% of the children with malaria who died were less than 5 years old (Table 1 and Fig. 2) and 52.3% were male. Overall, 34.9% of those who died had no diagnosis other than malaria; and the leading associated diagnoses were anaemia (27.1%), pneumonia (12.3%), and gastroenteritis (6.1%). Of the 1323 deaths from malaria, 823 (62.2%) occurred in the emergency ward prior to hospitalization, while the remaining 500 (38.2%) were among hospitalized patients.

Fig. 1. Age distribution of paediatric malaria admissions at Mama Yemo Hospital, Kinshasa, June 1985 to May 1986.

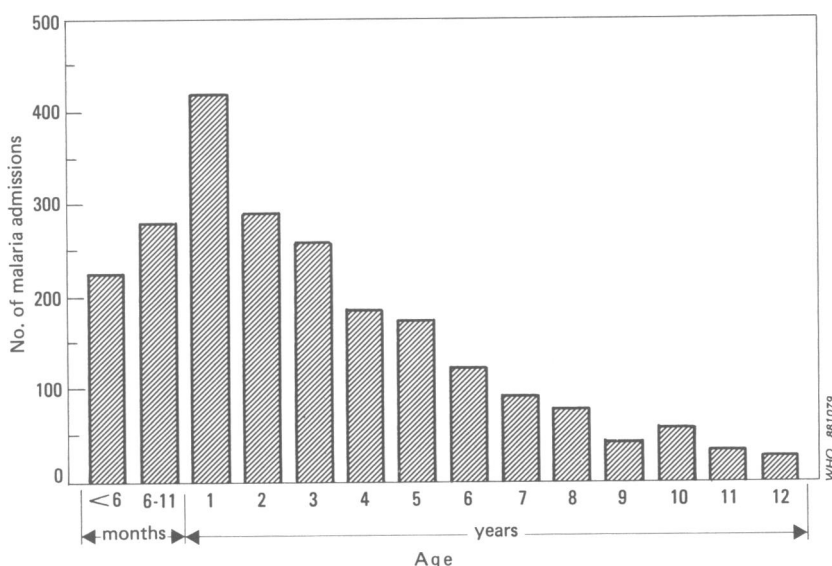


Table 1: Results of the 1-year survey of malaria admissions and deaths at Mama Yemo Hospital, Kinshasa, June 1985 to May 1986

	Age group				Total (0–13 years)
	<1 year	1–4 years	5–9 years	10–13 years	
No. of deaths from malaria	462 (34.9) ^a	641 (48.5)	183 (13.8)	37 (2.8)	1323 ^b (100)
No. of malaria admissions	508 (21.4)	1169 (49.2)	547 (23.0)	133 (5.6)	2374 ^c (100)
Case fatality rate for malaria admissions	31.8%	20.4%	14.8%	13.5%	21.1%
No. of children in Kinshasa	116 867	408 984	440 406	379 874	1 346 131
% of total census	4.3%	15.1%	16.3%	14.1%	49.9%
Minimum malaria mortality rate (per 1000 children)	4.0	1.6	0.4	0.1	1.0

^a Figures in parentheses are percentages.

^c Distributed thus: 823 (62.2%) in the emergency ward and 500 (37.8%) among hospitalized patients.

^c Includes 17 (0.7%) patients whose age was not recorded.

Minimum malaria mortality rates. The overall minimum malaria mortality rate was 1.0 per 1000 children per year (Table 1), with the highest age-specific mortality rate among those aged <1 year (4.0 per 1000) and decreasing progressively with age ($P < 0.001$, χ^2 test for trend).

Longitudinal survey

Malaria admissions. While the total number of paediatric admissions from all causes remained relatively constant (182 per month in 1983, 184 per month in 1984, 177 per month in 1985, and 193 per month in 1986), the proportional malaria admission rate increased significantly from 29.5% in 1983, 41.7% in 1984 and 45.6% in 1985 to 56.4% in 1986 ($P < 0.001$, χ^2 test for trend) (Fig. 3).

Malaria deaths. The total number of deaths from all causes among 0–13-year olds remained relatively constant (835 per month in 1982, 924 per month in 1983, 815 per month in 1984, 828 per month in 1985, and 981 per month in 1986); however, the proportional malaria mortality rate increased significantly from 4.8% in 1982, 7.0% in 1983, 7.9% in 1984 and 8.9 in 1985 to 15.3% in 1986 ($P < 0.001$, χ^2 test for trend) (Fig. 4).

Other causes of paediatric mortality

From January to December 1986, a total of 11 773 paediatric deaths were recorded at the hospital mortuary, 1803 (15.3%) of which were attributed to malaria, 674 (5.7%) to measles, and 376 (3.2%) to gastroenteritis (Fig. 5).

Fig. 2. Age distribution of paediatric malaria deaths at Mama Yemo Hospital, Kinshasa, June 1985 to May 1986.

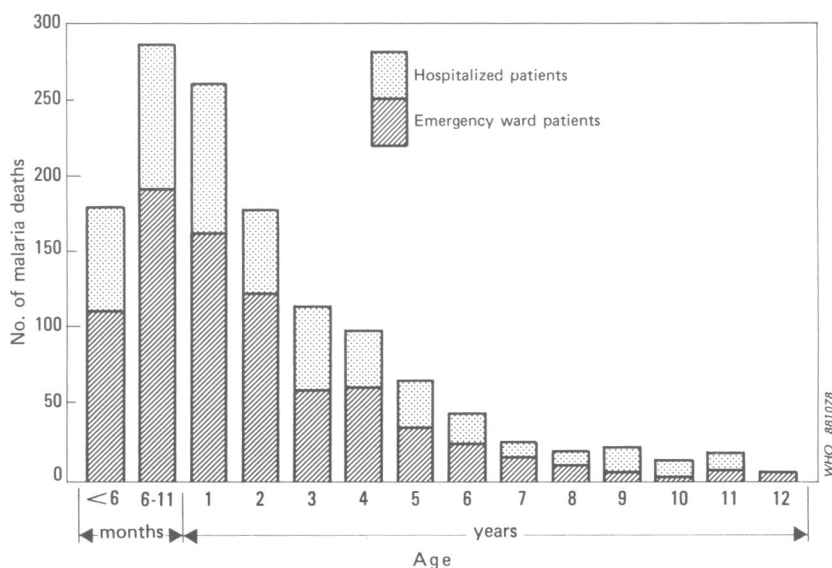


Fig. 3. (a) Total number of paediatric admissions and of paediatric malaria and (b) proportional malaria admission rate, pavilion 7, Mama Yemo Hospital, Kinshasa, 1983–86.

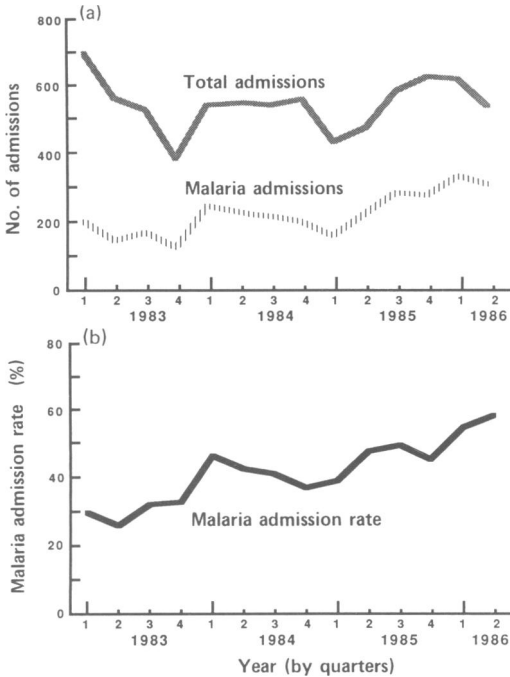
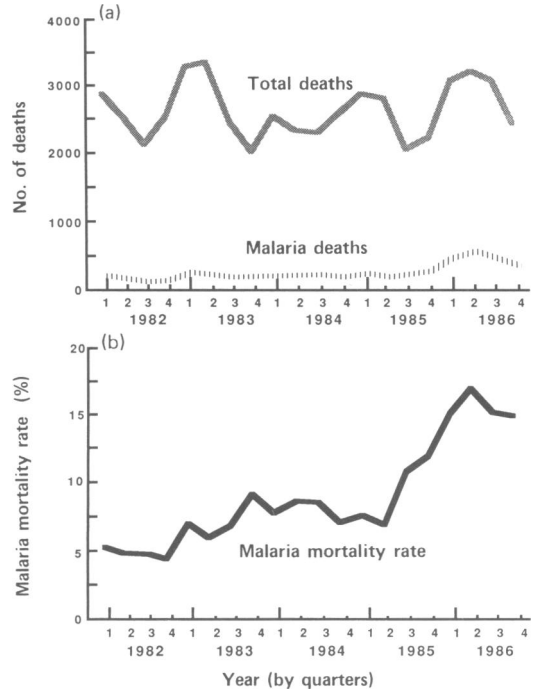


Fig. 4. (a) Total number of paediatric deaths from all causes and from malaria and (b) proportional malaria mortality rate, Mama Yemo Hospital, Kinshasa, 1982–86.



In March 1986, 1082 paediatric deaths were recorded at the mortuary, of which 28.5% did not occur in Mama Yemo Hospital and 25.4% involved neonates. By extrapolation, we therefore estimate that of the 11 773 paediatric deaths in 1986, a total of 3355 (28.5%) occurred outside the hospital and 2990 (25.4%) were neonatal deaths.

Discussion

The study demonstrates that malaria is a major cause of paediatric morbidity and mortality in Kinshasa and is of value in quantifying the impact of the disease on overall childhood survival in the city. Since malaria transmission patterns are heterogeneous in Africa, great caution must be exercised in extrapolating the data we have reported here to other populations. The total number of paediatric deaths reviewed in the study (52 606) is much larger than those reviewed in previous investigations of malaria-related mortality in Africa (1, 10, 11). However, the proportional malaria mortality rates found are similar to those reported in investigations that employed a variety of data sources and which

were conducted in geographically and temporally diverse situations (Tables 2 and 3).

Perhaps the most important finding is the striking increase in the malaria morbidity and mortality rates that occurred at Mama Yemo Hospital between 1982 and 1986. During this period there

Fig. 5. Distribution of causes of paediatric mortality, Mama Yemo Hospital, Kinshasa, January to December 1986.

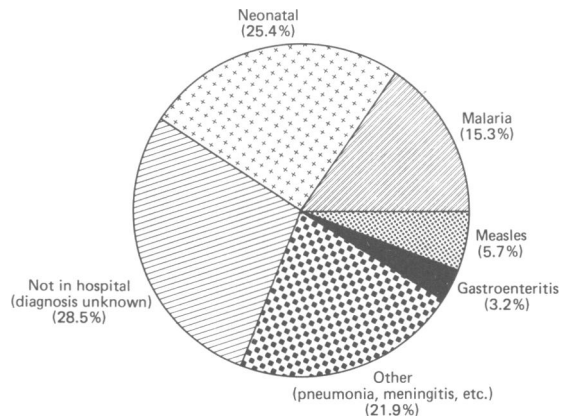


Table 2: Selected historical review of proportional malaria mortality rates

Period of study ^a	Investigators	Country	Data source	No. of paediatric deaths reviewed (all causes)	Percentage of deaths attributed to malaria, by age group					
					<1 year	1-4 years	5-10 years	11-15 years	0-15 years	0-15 years
1933-50	Bruce-Chwatt (1)	Nigeria (urban)	Autopsy reports Death certificates	3540 2103	8.5 9.0	14.2 16.2	7.1 18.6	1.8 9.1	9.9 12.4	9.9 12.4
1940-50	Duren (10)	Belgian Congo (urban and rural)	Autopsy reports Hospital records	1873 261	12.3 22	— 13.7 ^b	— —	— —	— —	— —
1982-83	Greenwood et al. (11)	Gambia (rural)	Family interviews	171	4	25	—	—	—	—
1982-86	Greenberg et al. ^c	Zaire (urban)	Mortuary records: 1982 1983 1984 1985 1986	52606	— — — — —	— — — — —	— — — — —	— — — — —	— — — — —	4.8 ^d 7.0 ^d 7.9 ^d 8.9 ^d 15.3 ^d

^a Indicates years for which rates were calculated.^b Figure refers to the age group 1-3 years.^c Present study.^d Figure refers to the age group 0-13 years.

Table 3: Selected historical review of population-based malaria mortality rates

Period of study ^a	Investigators	Country	Rates (per 1000 children), by age group							
			<1 year	1-3 years	4-6 years	7-9 years	10-14 years	15-19 years	20-24 years	25-29 years
1932-50	Duren (10)	Belgian Congo (urban and rural)	25-40	6-15	—	—	—	—	—	—
1950	Bruce-Chwatt (1)	Nigeria (urban)	12.5	—	6.6	—	1.0	—	0.3	—
1982-83	Greenwood et al. (11)	Gambia (rural)	6.3	—	10.7	—	—	—	—	—
1986	Greenberg et al. ^b	Zaire (urban) ^c	4.0	—	1.6	0.4	—	0.1	—	—

^a Indicates years for which rates were calculated.^b Present study.^c Minimum rates.

were no significant changes in diagnostic capabilities or in medical personnel at the hospital that could account for these results. However, the rapid development and intensification of chloroquine-resistant *P. falciparum* malaria in Kinshasa during the 5-year study interval may be related to the observed increase in the number of cases of severe malaria in the city. A similar trend was noted previously among children in Malawi upon the emergence of chloroquine-resistant malaria (12).

In 1982, no case of *in vivo* or *in vitro* chloroquine-resistant malaria was detected in Kinshasa (13). The first evidence of *in vivo* chloroquine resistance in the city was observed in 1984 (14), and by 1985 a total of 56% of *P. falciparum* infections in Kinshasa children were not cured by a standard regimen of 25 mg/kg chloroquine (15). By 1986, a total of 82% of *P. falciparum* parasites isolated from children at Mama Yemo Hospital exhibited *in vitro* resistance to the drug (16).

Kinshasa children who develop symptoms that are suggestive of malaria are often treated by their mothers or at local clinics with chloroquine. If, however, the children are infected with chloroquine-resistant strains of *P. falciparum*, their parasitaemia may increase with a consequent deterioration in clinical status; studies of the natural history of chloroquine-resistant malaria at the community level would therefore be useful in assessing this hypothesis. Additionally, prospective monitoring of malaria-related mortality in West Africa, where chloroquine resistance has only recently emerged (17), might indicate whether increases in malaria mortality reflect the changing drug-sensitivity patterns of *P. falciparum*.

In the 1-year review of malaria deaths at Mama Yemo Hospital, young children were identified as being at particularly high risk of malaria-related mortality. Of the paediatric malaria deaths, 83.4% occurred among children aged <5 years: 34.9% among infants aged <1 year and 48.5% among children aged 1–4 years. The case-fatality rate among hospitalized malaria patients was highest for infants (31.9%) and young children (20.4%). Since acquired immunity to malaria is least developed among younger age groups, these findings were not unexpected; however, the data emphasize the importance of the prompt diagnosis and management of malaria in young children.

An unexpected finding was that 62.2% of all paediatric deaths from malaria at Mama Yemo Hospital occurred among patients in the emergency ward. Since the hospital is a referral centre for patients with severe malaria in Kinshasa, a large proportion of children presenting to the emergency ward have not responded to therapy at other clinics

or medical centres, and it is, therefore, essential that they receive rapid and intensive clinical management soon after their arrival. Subsequent to this investigation, a separate room and a team of medical personnel were designated to provide more intensive care to patients requiring intravenous therapy or blood transfusions (the majority of whom have malaria). Ongoing surveillance of paediatric deaths at the hospital would help to determine whether this intervention will reduce malaria-related mortality.

We conclude that in Africa hospital-based surveillance of malaria at selected health care facilities, particularly those where the clinical diagnosis of malaria can be confirmed parasitologically, may be useful in monitoring whether improvements in health-care delivery programmes will have an impact on malaria-related mortality. Furthermore, this procedure could readily be adapted for the surveillance of other infectious and noninfectious diseases, thereby providing local health officials with data that could be used in the development of rational intervention programmes.

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Résumé

Surveillance en milieu hospitalier de la morbidité et de la mortalité dues au paludisme chez l'enfant à Kinshasa, Zaïre

Le paludisme à *Plasmodium falciparum* est l'une des causes majeures de morbidité et de mortalité chez l'enfant en Afrique. On ne dispose toutefois que de rares estimations quantitatives de son impact. Afin d'évaluer l'impact actuel du paludisme sur la mortalité infanto-juvénile en Afrique urbaine, nous avons examiné les registres du service de pédiatrie et de la morgue à l'hôpital Mama Yemo, Kinshasa, Zaïre.

De juin 1985 à mai 1986, 6208 enfants au total ont été admis à l'hôpital; sur les 2374 enfants (38,2%) qui étaient atteints de paludisme, 500 sont décédés (taux global de létalité, 21,1%; taux de létalité chez les nourrissons de moins d'un an:

30,8%). Au cours de la même période, la morgue de l'hôpital a enregistré 10 036 décès pédiatriques, dont 1323 (13,2%) étaient attribués au paludisme; parmi ces derniers, 823 (62,2%) ont été enregistrés au service des urgences, avant hospitalisation. Plus de 70% des enfants hospitalisés pour paludisme et plus de 80% des enfants décédés de cette maladie étaient âgés de moins de 5 ans. Le taux global minimal de mortalité par paludisme chez les enfants de Kinshasa était de 1,0 pour 1000 par an, le taux le plus élevé s'observant chez les nourrissons (4,0 pour 1000).

D'après les résultats d'une enquête longitudinale, que nous avons réalisée afin de déceler les tendances du paludisme grave, le nombre total d'admissions et de décès pédiatriques est resté relativement constant entre 1982 et 1986. Toutefois, la proportion de cas admis pour paludisme est passée de 29,5% en 1983 à 56,4% en 1986, et le taux proportionnel de mortalité palustre est passé de 4,8% en 1982 à 15,3% en 1986.

Afin d'identifier d'autres causes de mortalité pédiatrique, nous avons examiné les registres de la morgue de l'hôpital pour la période s'étendant de janvier à décembre 1986. Pendant cette période, 11 773 décès pédiatriques ont été enregistrés, dont 1803 (15,3%) attribués au paludisme, 674 (5,7%) à la rougeole, 376 (3,2%) à une gastro-entérite, 3355 (28,5%) décès survenus en dehors de l'hôpital, et 2990 (25,4%) décès de nouveaux.

Cette étude démontre que le paludisme est une cause majeure de morbidité et de mortalité infanto-juvéniles à Kinshasa. Le risque de décès dû au paludisme est particulièrement élevé chez les très jeunes enfants et les enfants admis dans les services d'urgence. L'augmentation frappante de la morbidité et de la mortalité palustres observée à l'hôpital Mama Yemo entre 1982 et 1986 peut être liée à l'apparition et à l'intensification rapides du paludisme à *P. falciparum* chloroquinorésistant à Kinshasa pendant cette même période. Nous concluons que la surveillance hospitalière dans des établissements sélectionnés peut être utile pour surveiller la morbidité et la mortalité infanto-juvéniles dues au paludisme en Afrique.

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